

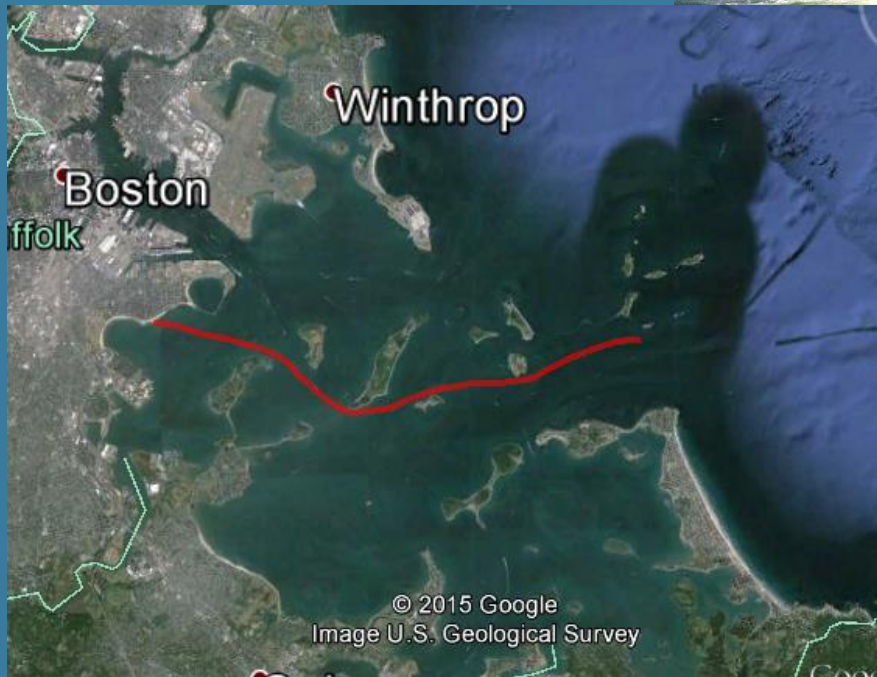
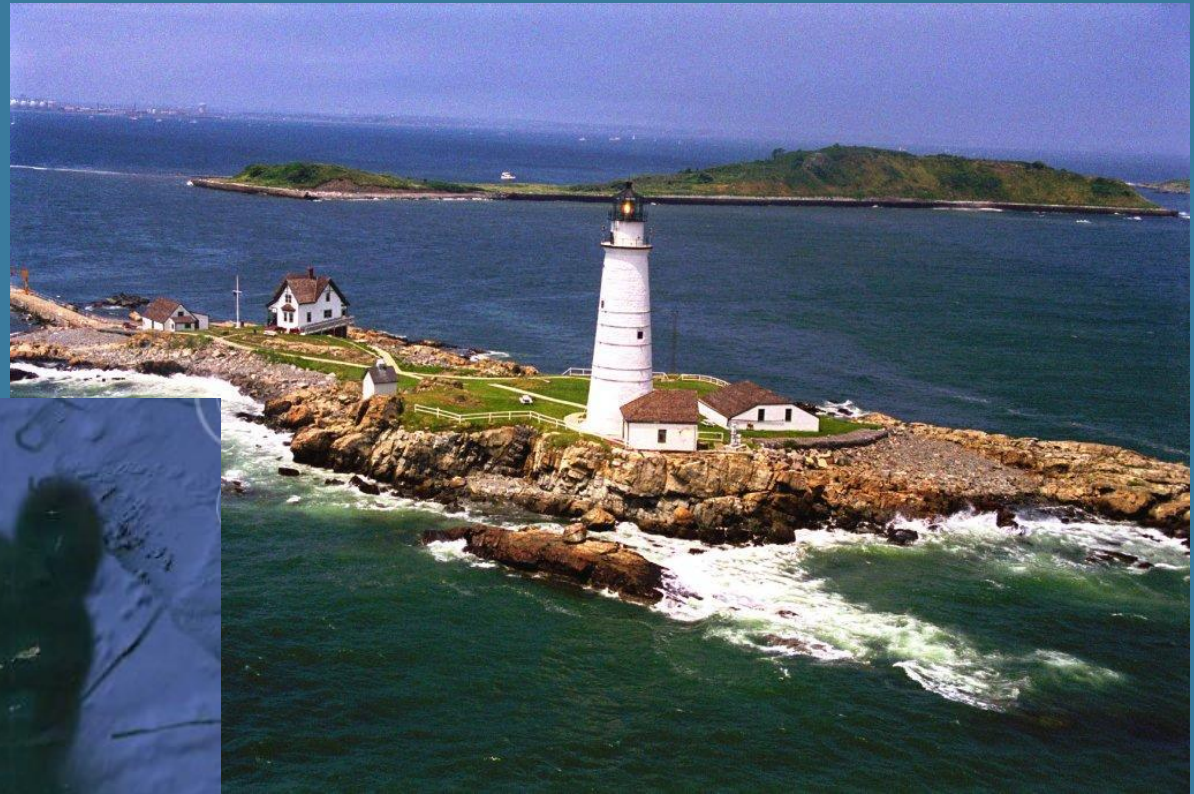


Catalog-driven, Reproducible Workflows for Ocean Science

Rich Signell , USGS, Woods Hole, MA, USA

Filipe Fernandes, Centro Universidade Monte Serrat, Santos, Brazil.

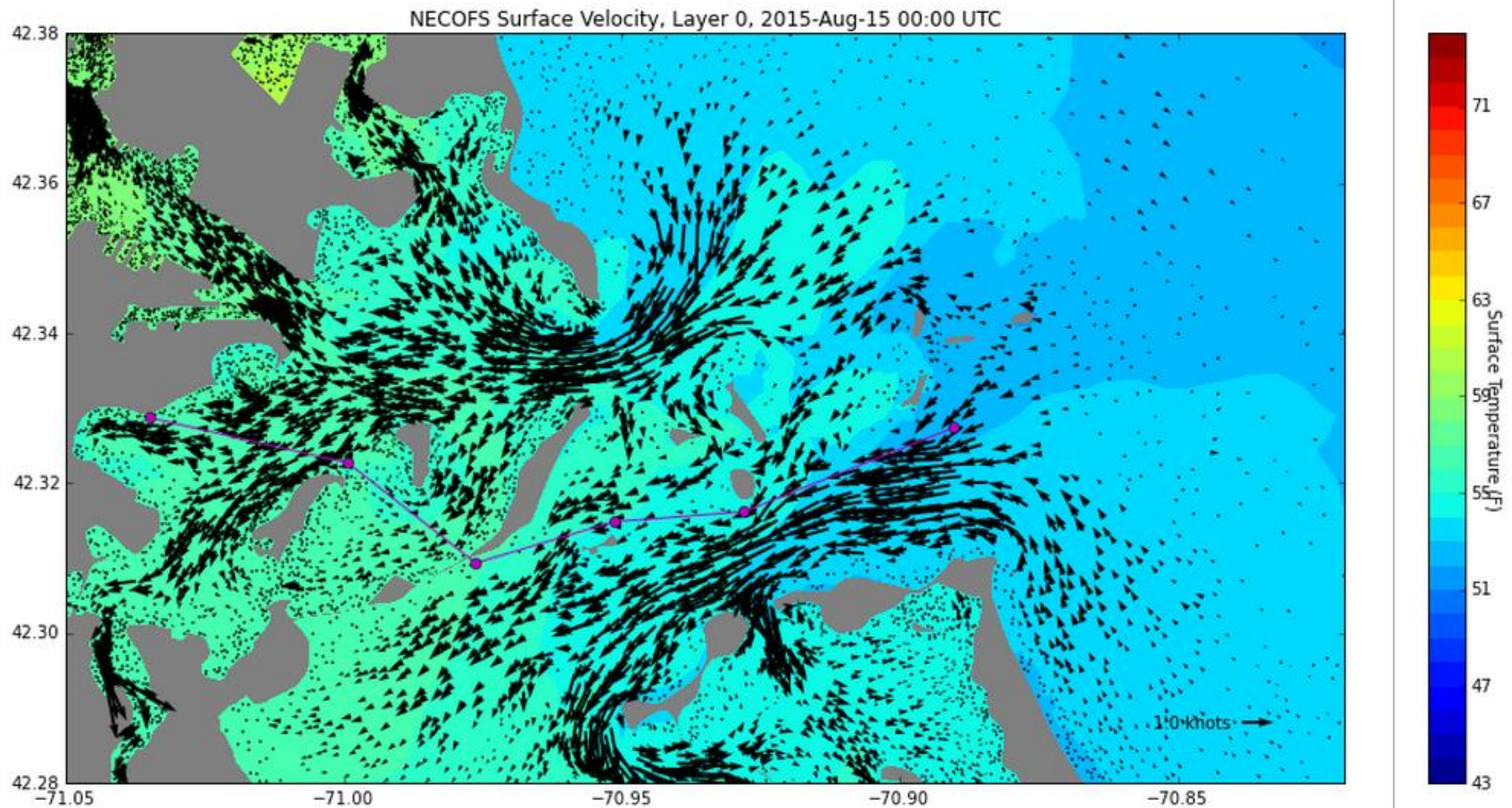
2015 Boston Light Swim, Aug 15, 7:00am since 1907, 8 miles, no wet suit



How cold will the water be?

NECOFS Massbay Forecast

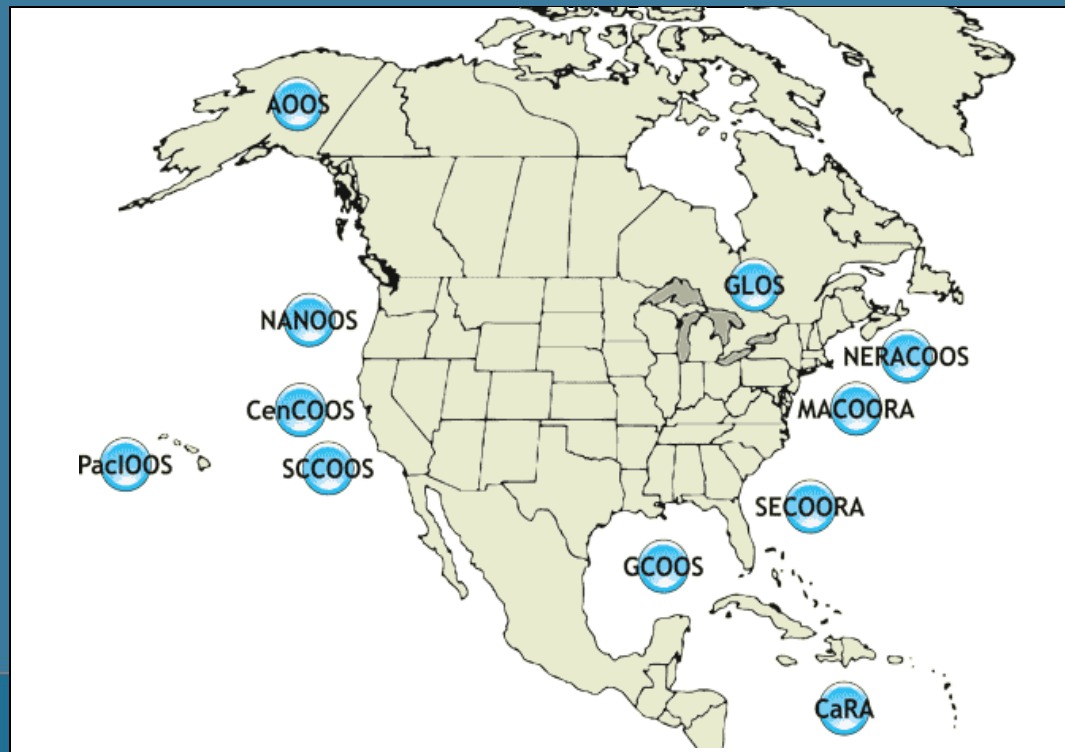
```
maxstr='%3.1f knots' % maxvel  
qk = plt.quiverkey(Q,0.92,0.08,maxvel,maxstr,labelpos='W')  
plt.title('NECOFS Surface Velocity, Layer %d, %s UTC' % (ilayer, daystr))  
plt.plot(lon_track,lat_track,'m-o');
```



US Integrated Ocean Observing System (IOOS[®])

IOOS[®] Plan defines:

- Global Component
- Coastal Component
 - 17 Federal Agencies
 - 11 Regional Associations



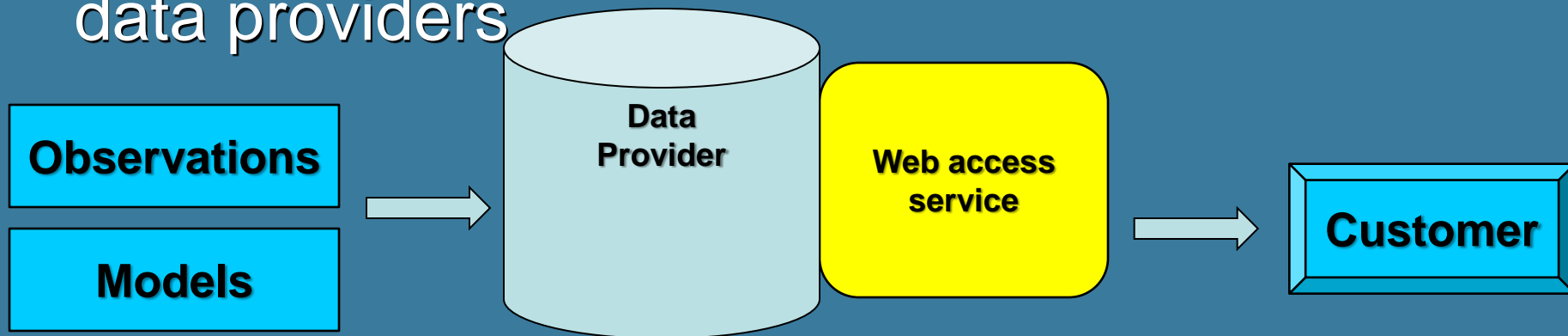
**SECOORA
Model Skill-
Assessment
Project:
Deborah
Hernandez and
Vembu
Subramanian**

IOOS Core Principles

- Adopt open standards & practices



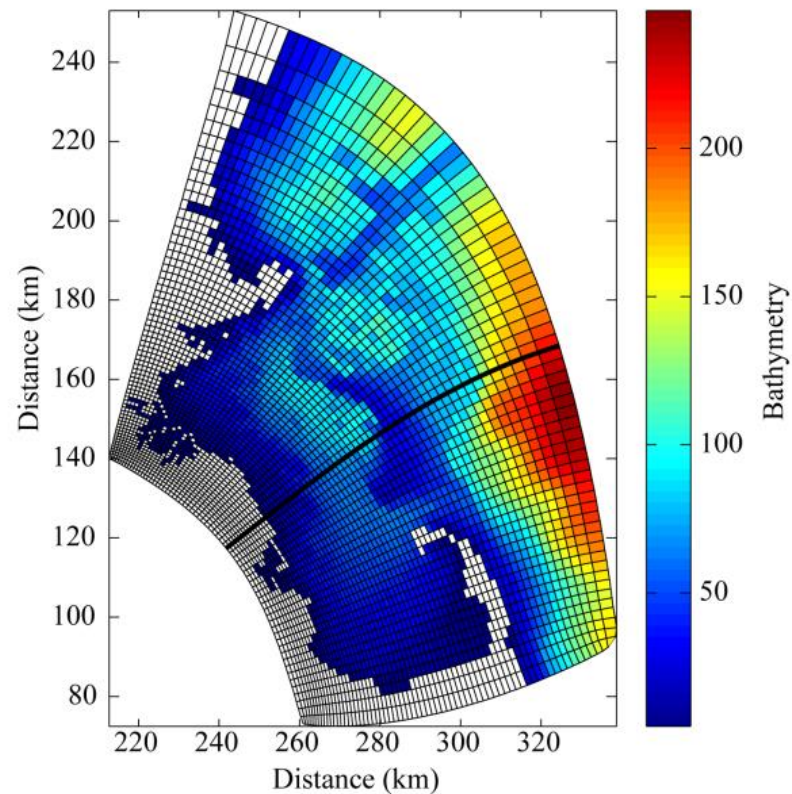
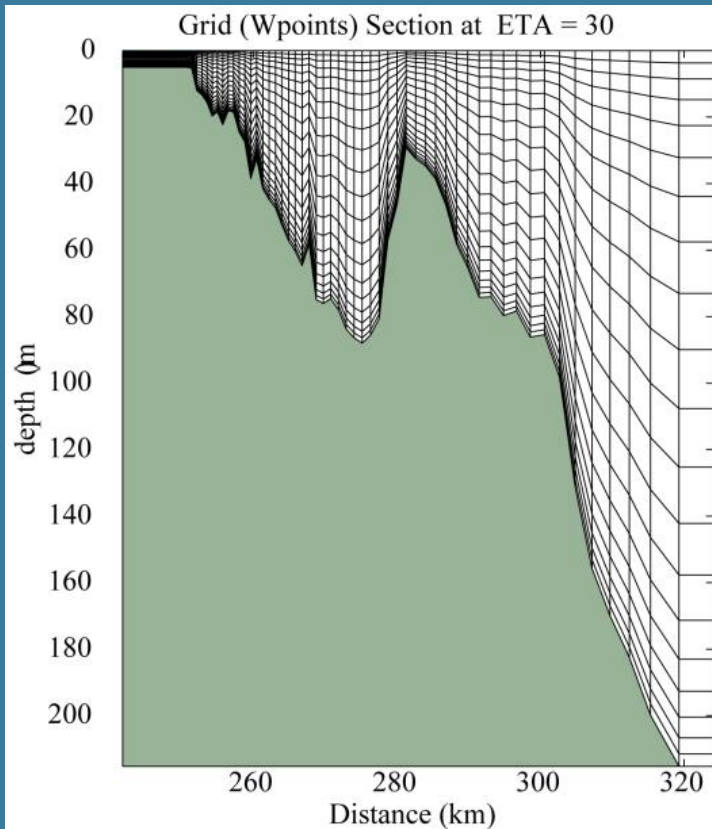
- Avoid customer-specific stovepipes
- Standardized access services implemented at data providers



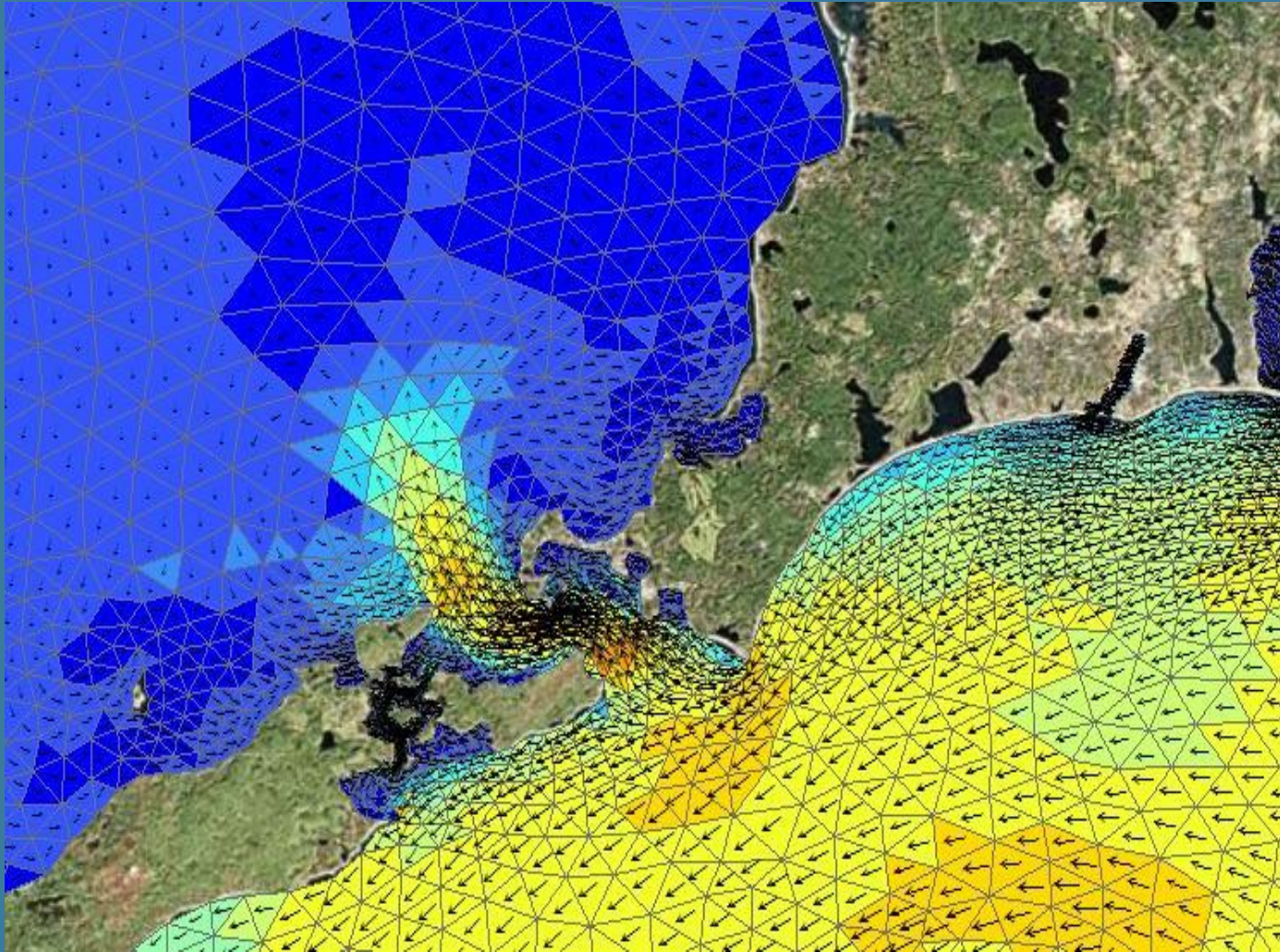
Ocean grids are often not regularly spaced!

Stretched surface and terrain
following vertical coordinates

Curvilinear orthogonal
horizontal coordinates



Unstructured (e.g. triangular) grid



Time Series, Trajectories



Meteorology and Wave Buoy in the Gulf of Maine. Image courtesy of NOAA.

Ocean Glider. Photo by Dave Fratantoni, Woods Hole Oceanographic Institution



NetCDF Climate and Forecast (CF) Conventions provide a solution

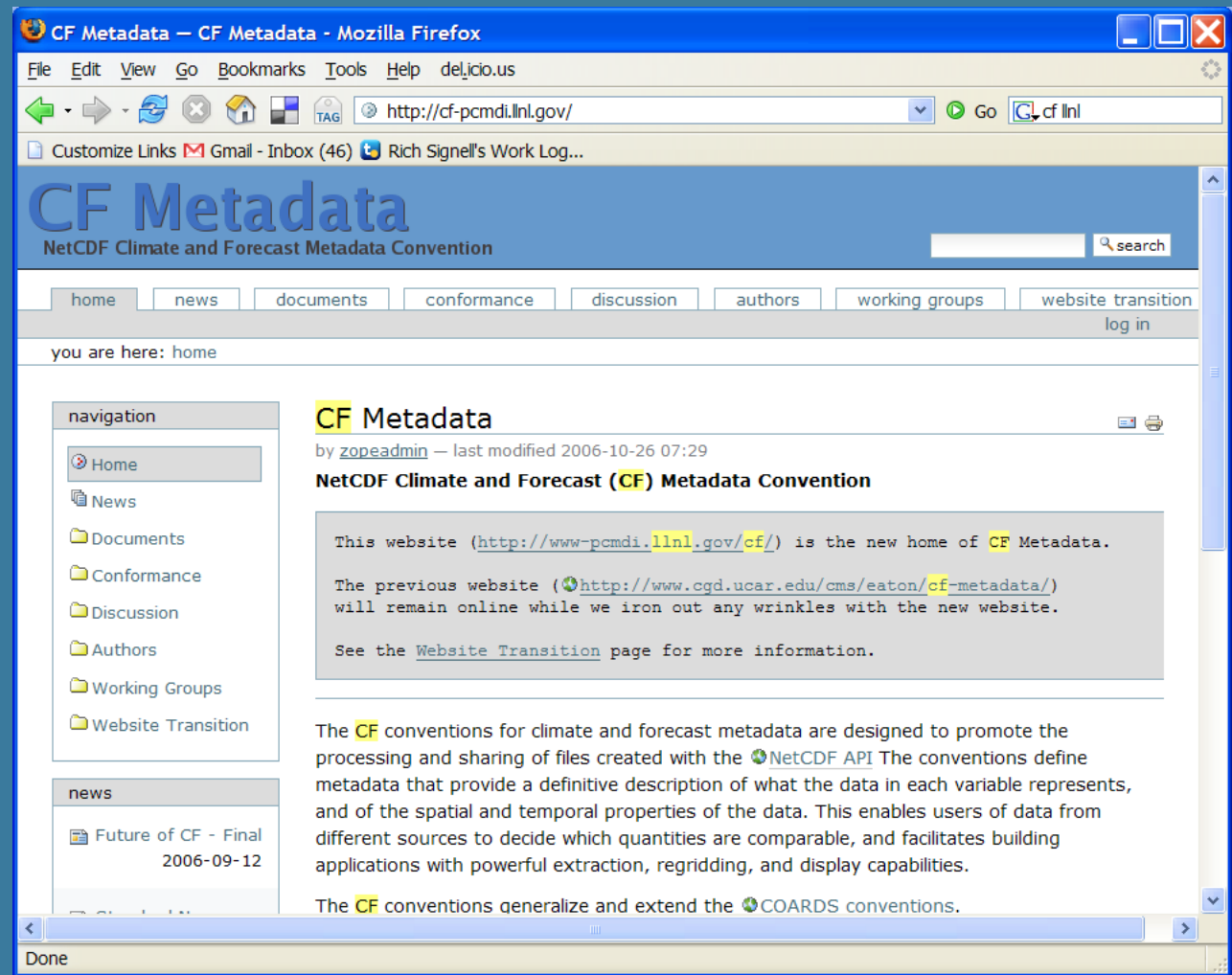
Groups using CF:

GO-ESSP: Global Organization for Earth System Science Portal

IOOS: Integrated Ocean Observing System

ESMF: Earth System Modeling Framework

OGC: Open Geospatial Consortium (GALEON: WCS profile)



CF Convention Draft Spec for
Unstructured Grid: http://bit.ly/ugrid_cf



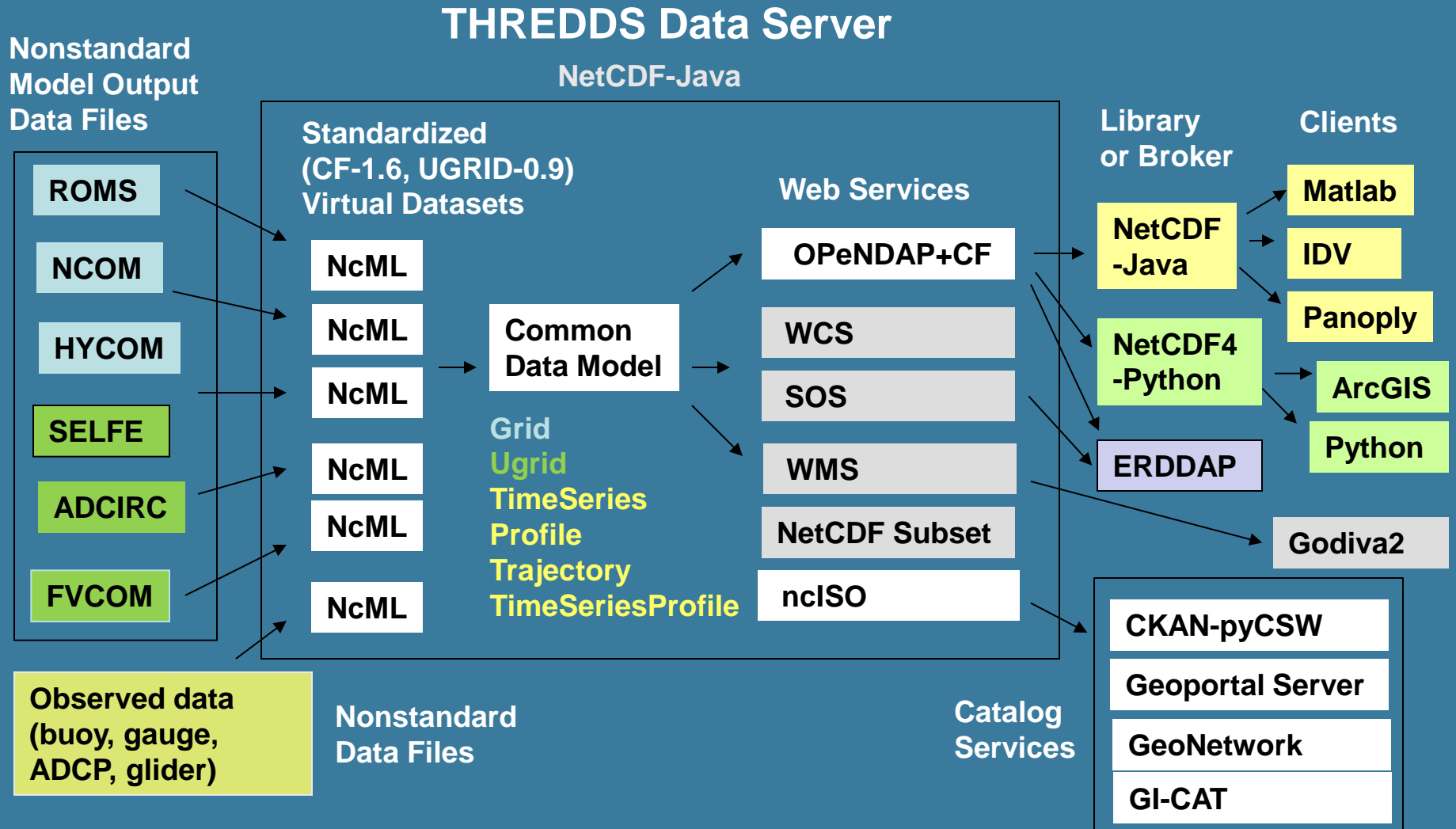
IOOS Recommended Web Services and Data Encodings

Data Type	Web Service	Encoding
In-situ data (buoys, piers, towed sensors)	OGC Sensor Observation Service (SOS)	XML or CSV
Gridded data (model outputs, satellite)	OPeNDAP with Climate and Forecast Conventions	Binary DAP using Climate and Forecast (CF) conventions
Images of data	OGC Web Map Service (WMS)	GeoTIFF, PNG etc. -possibly with standardized styles

OGC Sensor Observation Service (SOS)

- Provides standard access to sensor data
 - **GetCapabilities**: provides the means to access SOS service metadata
 - **DescribeSensor** - retrieves detailed information about the sensors and processes generating those measurements.
 - **GetObservation** - provides access to sensor observations and measurement data via a spatio-temporal query that can be filtered by phenomena

IOOS Data Infrastructure Diagram



Metadata harvest for Catalog Search

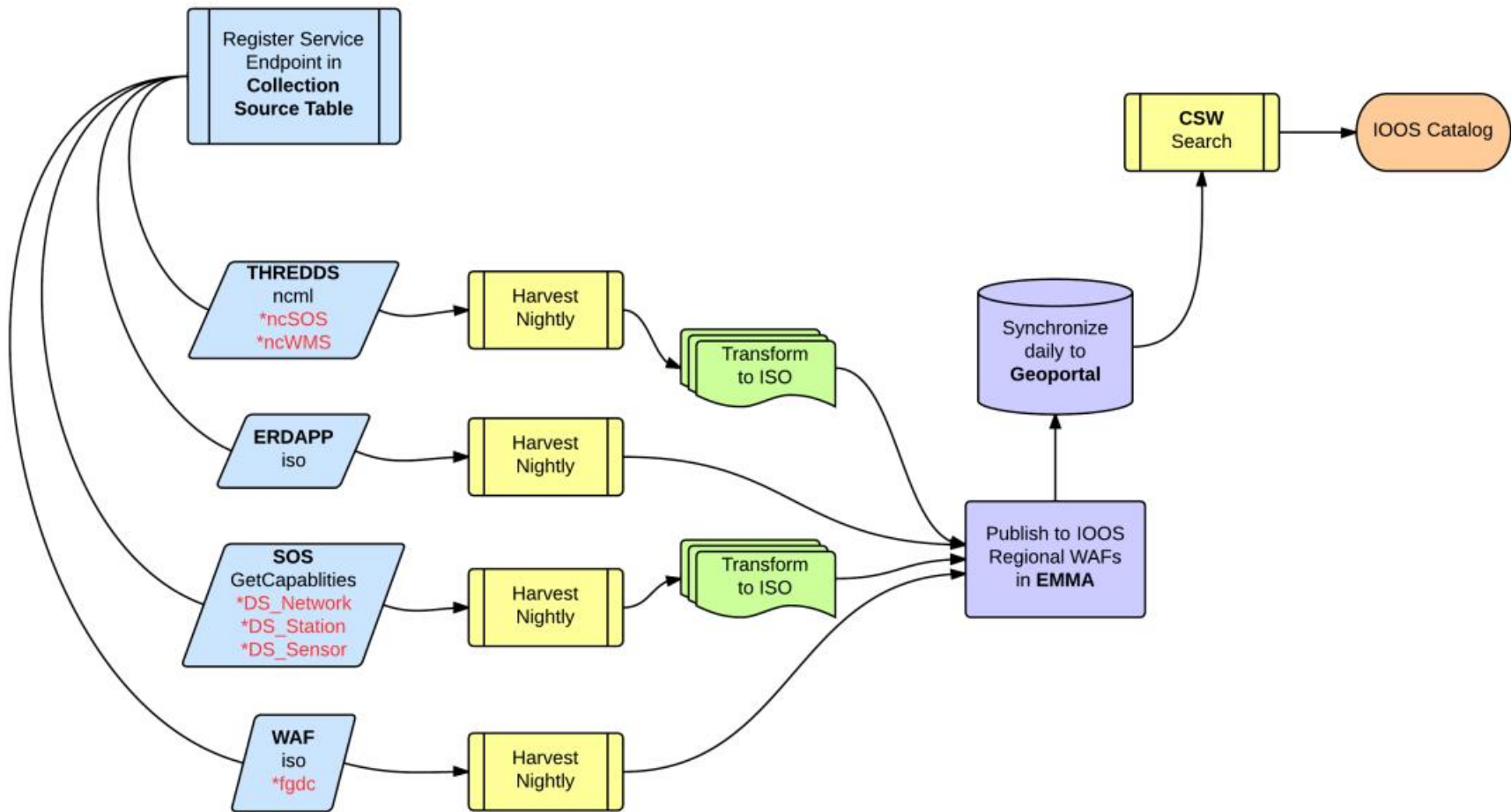


Figure 1: IOOS service metadata registration steps



Iris: Data Access using OPeNDAP+CF:

IP[y]: Notebook

Iris test 2

Last saved: Mar 28 10:17 AM

File Edit View Insert Cell Kernel Help

Code Cell Toolbar: None

```
In [12]: # DAP URL: 30 year East Coast wave hindcast (Wave Watch 3 driven by CFSR Winds)
cubes = iris.load('http://geoport.whoi.edu/thredds/dodsC/fmrc/NCEP/ww3/cfsr/4m/best');
```

```
In [13]: print cubes
```

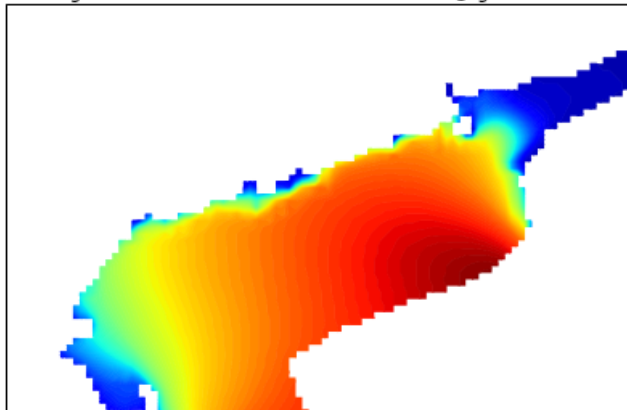
```
0: Significant height of combined wind waves and swell @ Ground or water surface / m (time: 90584; latitude: 481; longitude: 586)
1: u-component of wind @ Ground or water surface / m/s (time: 90096; latitude: 481; longitude: 586)
2: v-component of wind @ Ground or water surface / m/s (time: 90096; latitude: 481; longitude: 586)
3: Primary wave direction (degree true) @ Ground or water surface / unknown (time: 90584; latitude: 481; longitude: 586)
4: Primary wave mean period @ Ground or water surface / s (time: 90584; latitude: 481; longitude: 586)
```

```
In [14]: hsig=cubes[0]
```

```
In [15]: slice=hsig.extract(iris.Constraint(time=tval(hsig,'1989-05-07 21:00'),
        longitude=lambda cell: -71.5 < cell < -65.0,
        latitude=lambda cell: 39.5 < cell < 46.0))
```

```
In [16]: # make the plot
figure(figsize=(10,10))
plt.contourf(slice,100);
```

Significant height of combined wind waves and swell @ ground or water surface



scitools.org.uk/iris

Inbox (...) Bank of America



Home Download Documentation

A Python library for Climate Data Analysis

The Iris library implements a standard interface for analysis and visualisation of climate data. The chosen is the CF Data Model (CF-1.4) Cube.

Iris currently supports reading and writing netCDF, GRIB, and PP; full support for interpolation, and statistical analysis.

Iris is published under an LGPL license.



OWSLib for SOS and CSW

OWSLib 0.8.8 documentation



\$1.62M Cost

Author: Tom Kralidis
Contact: tomkralidis at gmail.com
Release: 0.8.8
Date: 2014-07-05

Introduction

OWSLib is a Python package for client programming with [Open Geospatial Consortium](#) (OGC) standards, and their related content models.

OWSLib was buried down inside PCL, but has been brought out as a separate project in r481.

Features

Standards Support

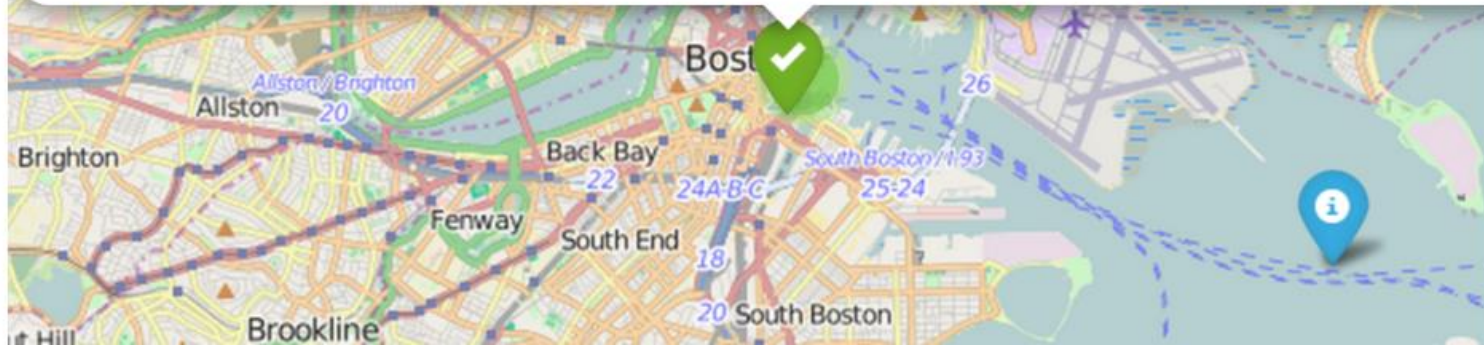
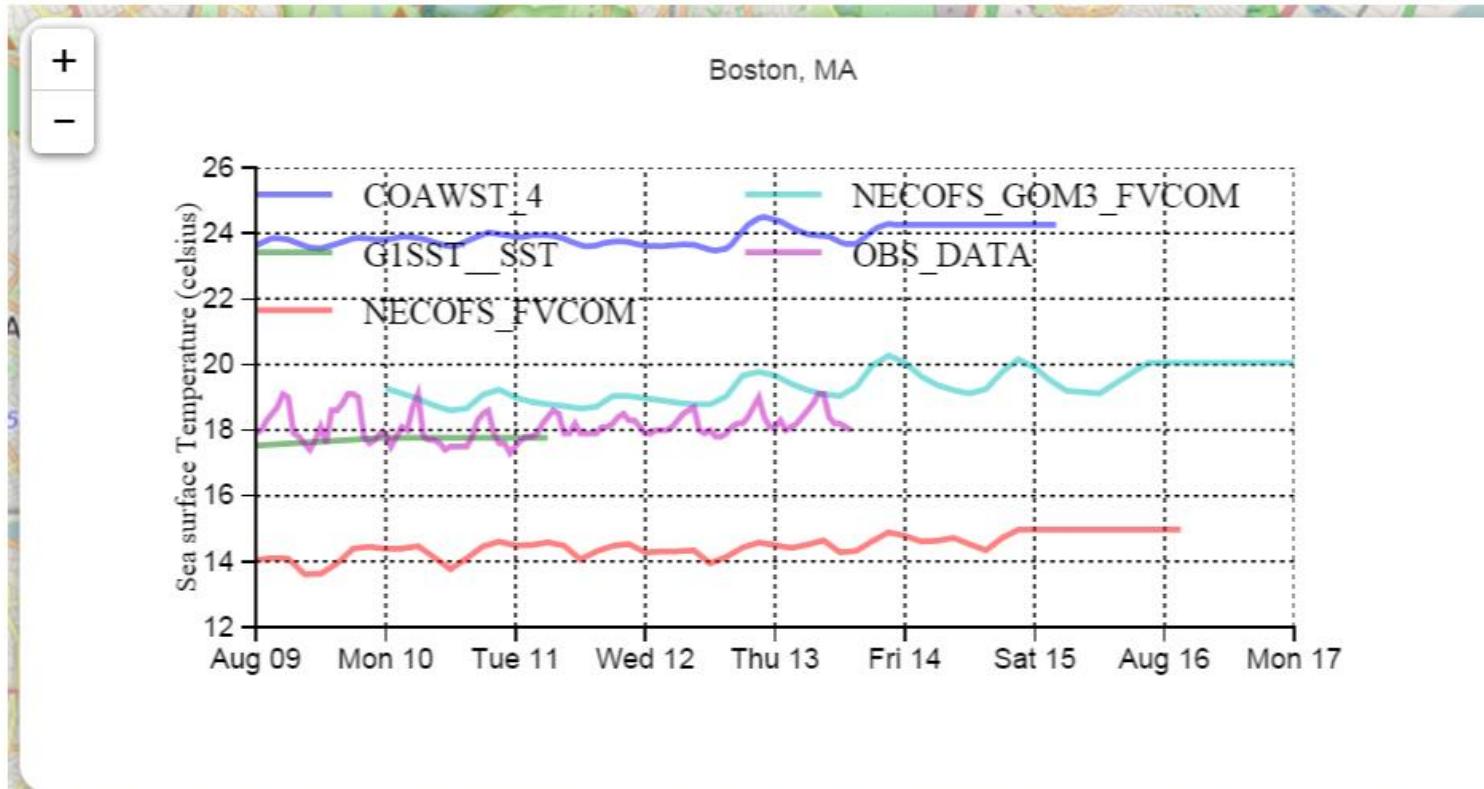
Standard	Version(s)
OGC WMS	1.1.1
OGC WFS	1.0.0, 1.1.0, 2.0.0
OGC WCS	1.0.0, 1.1.0
OGC WMC	1.1.0
OGC SOS	1.0.0, 2.0.0
OGC SensorML	1.0.1
OGC CSW	2.0.2



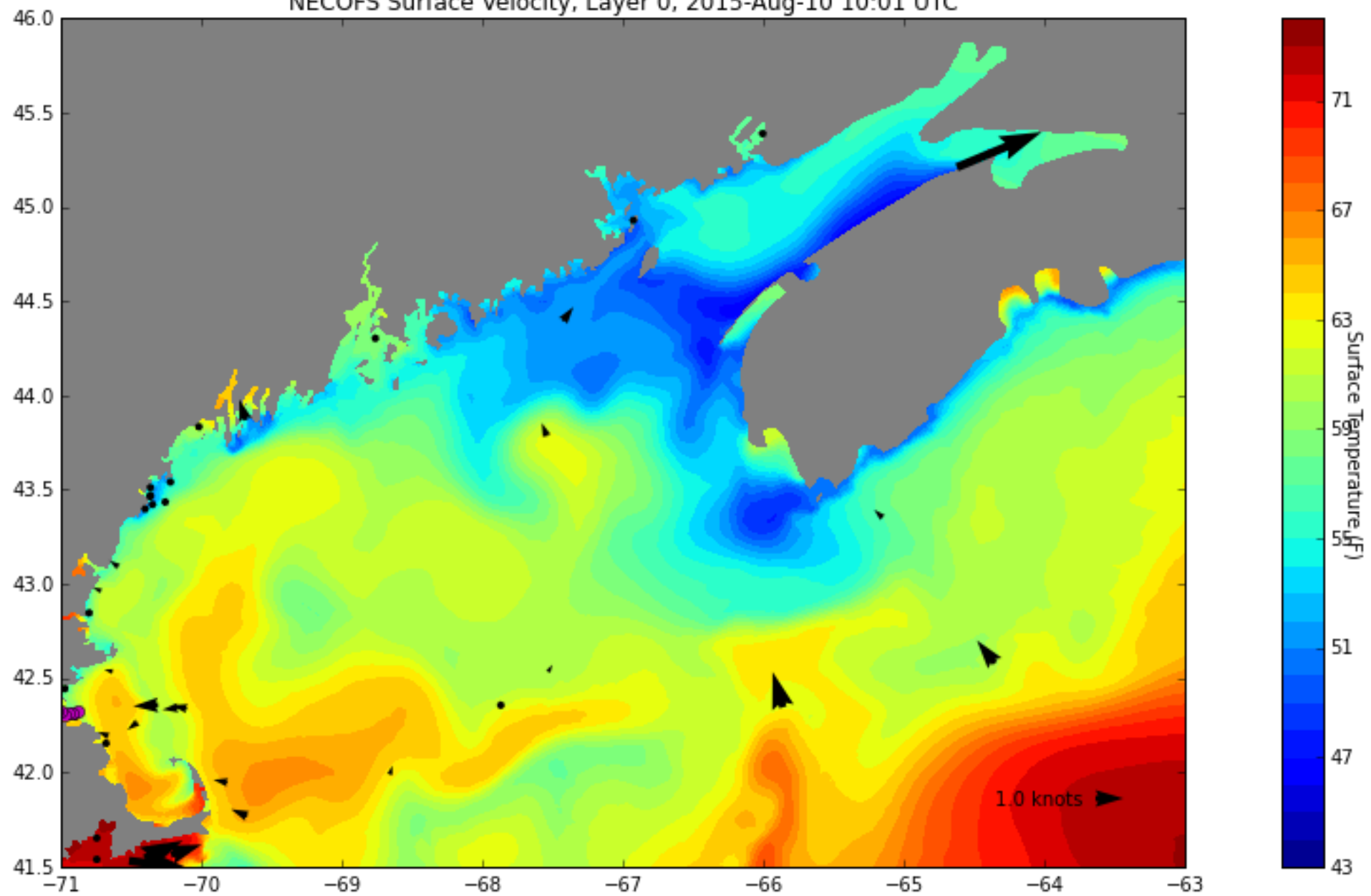
Code Cell Toolbar: None

```
inline_map(os.path.join(run_name, 'mapa.html'))
```

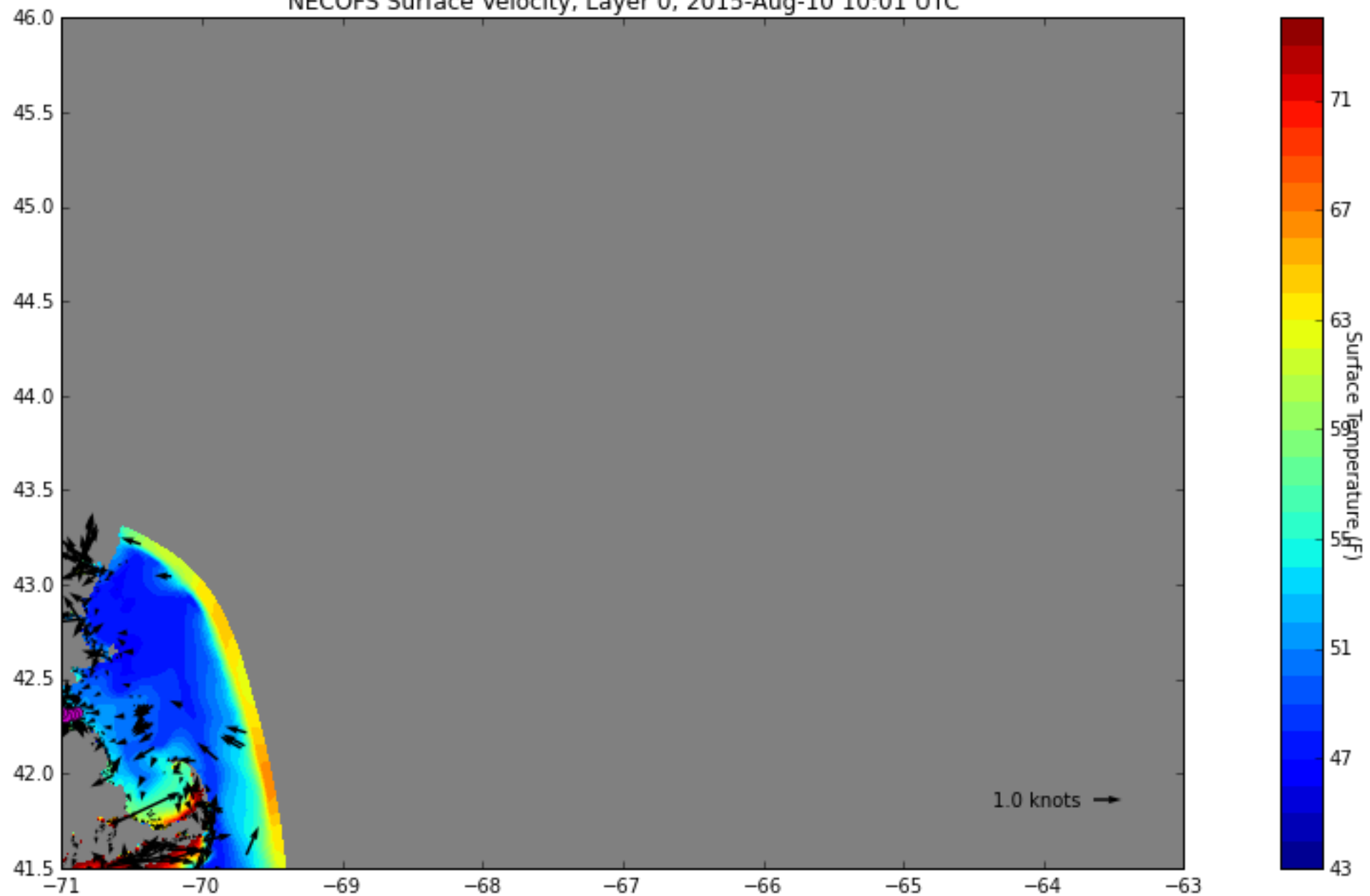
Out[7]:




NECOFS Surface Velocity, Layer 0, 2015-Aug-10 10:01 UTC








NECOFS Surface Velocity, Layer 0, 2015-Aug-10 10:01 UTC



rsignell-usgs | ocefpaf & github





Rich Signell
rsignell-usgs

 USGS
 Woods Hole, MA
 rsignell@usgs.gov
 <http://about.me/rich.signell>
 Joined on Jun 20, 2012


56 Followers **2** Starred **9** Following


Organizations






[Pull requests](#) [Issues](#) [Gist](#)








[Pull requests](#) [Issues](#) [Gist](#)



Filipe
ocefpaf

 ocefpaf@gmail.com
 <http://ocefpaf.github.io/python...>
 Joined on Jul 31, 2011

40 Followers **34** Starred **4** Following

[Contributions](#)

[Repositories](#)

[Public activity](#)

boston_light_swim

Sea Surface Temperature forecast for the Boston Light Swim

Updated 2 hours ago

utilities

🍴 forked from [pyoceans/utilities](#)

Misc utilities functions for SECOORA

Updated 2 hours ago

conda-recipes

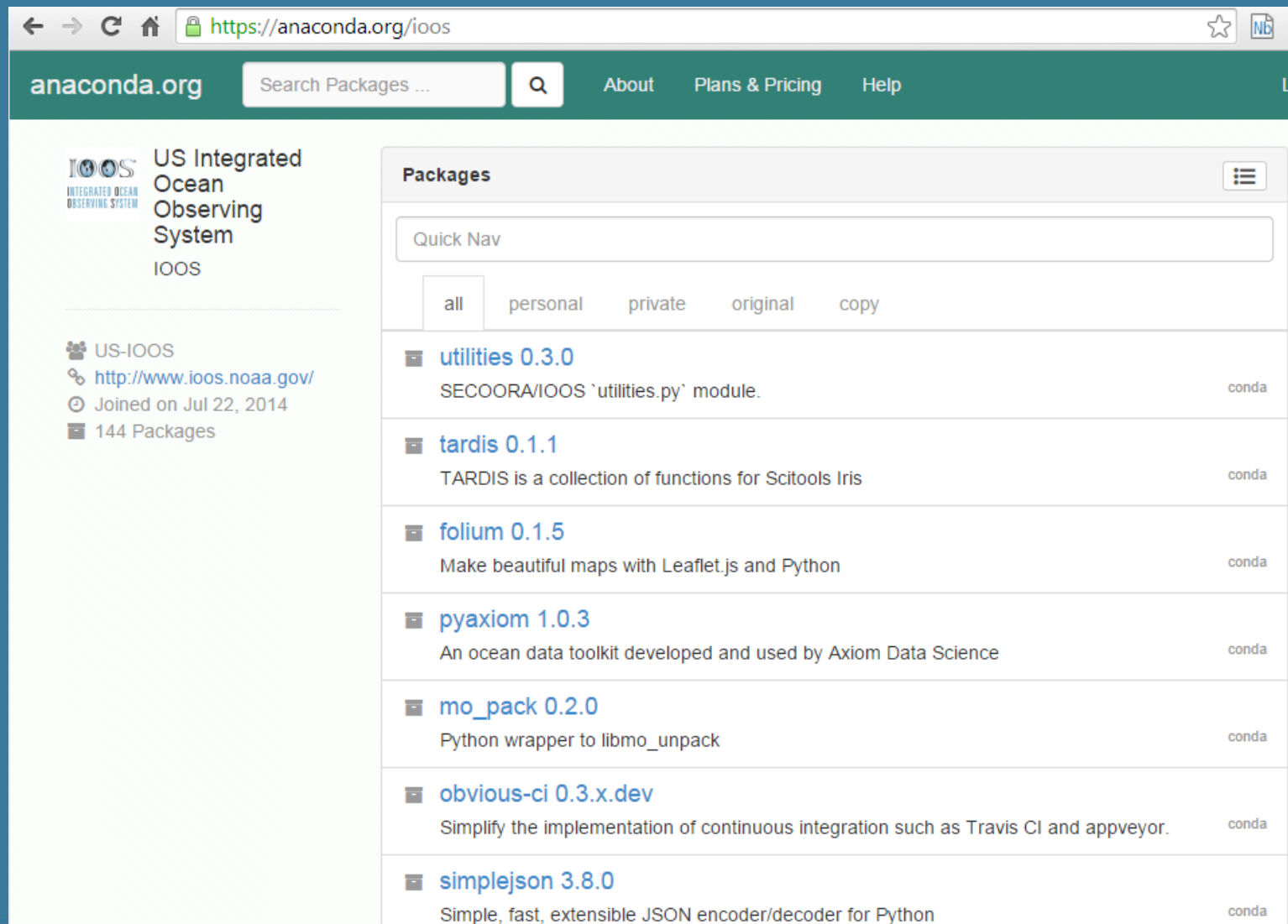
🍴 forked from [ioos/conda-recipes](#)

conda-recipes for IOOS packages

Updated 3 hours ago

🔗 5 commits

144 python packages on IOOS channel!



The screenshot shows the Anaconda.org website with the IOOS channel selected. The header includes the Anaconda logo, a search bar, and navigation links. The left sidebar displays the IOOS logo and channel information. The main content area lists several Python packages available on the channel.

anaconda.org Search Packages ... **Q** About Plans & Pricing Help

IOOS US Integrated Ocean Observing System
IOOS


US-IOOS
<http://www.ioos.noaa.gov/>
Joined on Jul 22, 2014
144 Packages

Packages



Quick Nav


all personal private original copy

- utilities 0.3.0**
SECOORA/IOOS 'utilities.py' module. conda
- tardis 0.1.1**
TARDIS is a collection of functions for Scitools Iris conda
- folium 0.1.5**
Make beautiful maps with Leaflet.js and Python conda
- pyaxiom 1.0.3**
An ocean data toolkit developed and used by Axiom Data Science conda
- mo_pack 0.2.0**
Python wrapper to libmo_unpack conda
- obvious-ci 0.3.x.dev**
Simplify the implementation of continuous integration such as Travis CI and appveyor. conda
- simplejson 3.8.0**
Simple, fast, extensible JSON encoder/decoder for Python conda



[Pull requests](#)
[Issues](#)
[Gist](#)


[ioos / conda-recipes](#)

[Unwatch](#) 18
 [Star](#) 7
 [Fork](#) 17


conda-recipes for IOOS packages — Edit


 756 commits
  1 branch
  0 releases
  11 contributors

 Branch: **master**

[conda-recipes / +](#)





 Merge pull request #375 from ocefpaf/update_utilities

 ocefpaf authored 4 hours ago



latest commit ccd9af03d8


- 00_env_requirements/ioos
- affine
- airsea
- appdirs
- argh
- beautifulsoup4
- betamax-matchers
- betamax
- biggus
- cartopy

 <https://github.com/ioos/conda-recipes/wiki>



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[Issues](#)
[Gist](#)


[ioos / conda-recipes](#)

[Unwatch](#) 18
 [Star](#) 7
 [Fork](#) 17

Home

Rich Signell edited this page on Mar 24 · 21 revisions

[Edit](#)
[New Page](#)

The IOOS Python Environment

The recipes here create conda packages useful to the IOOS community. These packages are shared with the community at [Binstar.org](#).

For IOOS python users, we recommend the [Anaconda Scientific Python Distribution](#) as the easiest way to get all the custom packages needed to run the IOOS system tests.

[more info](#)

Install

- Install on [Linux 64-bit](#)
- Install on [Windows 64-bit](#)
- Install on [Mac OS X 64-bit](#)

Pages 10

- [Home](#)
- [Conda Build Notes](#)
- [Customizing the notebook settings](#)
- [Setting up the IOOS Anaconda Python environment for MacOS64](#)
- [Setting up the IOOS Python environment for Linux64](#)
- [Setting up the IOOS Python Environment for Win64](#)
- [Testing the IOOS environment](#)
- [Updating an IOOS binstar](#)



Summary


- Standards, web services and catalogs allow us to serve data in a unified way
- Python gives us a free scientific access, analysis and visualization environment
- Ipython/Jupyter notebooks give us documented workflows and browser interface
- Anaconda and anaconda.org lets anyone easily reproduce our workflows
- Result: more efficient and effective access to ocean data, and anyone can assess ocean model skill

Client Software Stack

- **Environment**
 - IPython Notebooks, Anaconda, Binstar, Wakari, Github
- **Search**
 - CSW using OWSLib
- **Access**
 - OPenDAP+CF using Iris and Pyugrid
 - Sensor Observation Service (SOS) using OWSLib and PyOOS
- **Analysis and Plotting**
 - Scipy, Pandas, Matplotlib, Cartopy, Vincent, Folium

Using Github issues for everything

PUBLIC

 ioos / system-test

Unwatch

19

Star

2

Fork

7

Browse Issues

Milestones

New issue

Everyone's Issues35

Assigned to you2

Created by you11

Mentioning you9

No milestone selected

Labels

client-issue1

data-provider-issue8

documentation3

enhancement2

high priority2

low priority2

medium priority5

progress4

question1

registry-issue4

35 Open70 Closed

Sort: Newest

12

CloseLabelAssigneeMilestone

Scenario 2A Waves Progressprogress#105

Opened by Bobfrat 7 days ago4 comments

Caricoos buoy data not appearing in SOS requestsdata-provider-issue#104

Opened by Bobfrat 10 days ago

Updates to Scenario 3A#103

Opened by kwilcox 10 days ago7 comments

When looking at DAP endpoints unable to discern between model and obs wontfix#102

Opened by birdage 11 days ago5 comments

CO-OPS SOS service only allows 4 day current requestsdata-provider-issue#101

Opened by birdage 11 days ago4 comments

What to do when SOS reports no NAVD88 datum?#100

Opened by rsignell-usgs 14 days ago5 comments


Scenario 2A Extreme Water Level Progressprogress#96

Opened by Bobfrat 24 days ago

Pyoos collector needs to be defined during initialization for SOS endpoint#94

Opened by birdage 25 days ago2 comments

Using Github to Capture Successes & Lessons Learned

PUBLIC  **ioos / system-test** Unwatch 19 Star 2 Fork 7


[Browse Issues](#) [Milestones](#) [New issue](#)

Everyone's Issues 4

Assigned to you 1

Created by you 1

Mentioning you 0

No milestone selected 

Labels

- client-issue 1
- data-provider-issue 8
- documentation 3
- enhancement 2
- high priority 2
- low priority 2
- medium priority 5
- progress** 4
- question 1

Clear milestone and label filters


4 Open 0 Closed Sort: **Newest**

☐ **Scenario 2A Waves Progress** **progress** #105
Opened by Bobfrat 7 days ago 4 comments

☐ **Scenario 2A Extreme Water Level Progress** **progress** #96
Opened by Bobfrat 24 days ago

☐ **Scenario 3A, Assessing Seabird Vulnerability in the Bering Sea Progress** **progress** #90
Opened by wckoeppen 27 days ago 2 comments

☐ **Scenario_2A_Water_Level_Signell Progress** **progress** #82
Opened by rsignell-usgs on May 29

Keyboard shortcuts available 

OWSlib CSW

```
1 for url in dap_urls:
2     nc = netCDF4.Dataset(url).variables
3     time_var = nc['time']
4     dtime = netCDF4.num2date(time_var[:],time_var.units)
5     d = standard_names(nc)
6     data_dict={}
7     for v in d[std_name]:
8         data_dict[v]=nc[v][:].flatten()
9         # Create Pandas data frame, with time index
10    ts = pd.DataFrame.from_dict(data_dict)
11    ts.index=dtime
12    ts.plot(figsize=(12,4));
```

OGC Catalog Services for the Web (CSW)

- Provides standardized services for search
 - **GetCapabilities** : returns the list of queryables
 - **GetRecords** : allows geospatial, temporal, keyword and free text search (and other queryables)

CSW Request

```
<?xml version="1.0"?>
<csw:GetRecords xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" version="2.0.2" service="CSW" resultType="results"
outputSchema="http://www.isotc211.org/2005/gmd" startPosition="1" maxRecords="1000">
  <csw:Query typeNames="csw:Record" xmlns:ogc="http://www.opengis.net/ogc" xmlns:gml="http://www.opengis.net/gml">
    <csw:ElementSetName>full</csw:ElementSetName>
    <csw:Constraint version="1.1.0">
      <ogc:Filter>
        <ogc:And>
          <ogc:PropertyIsEqualTo>
            <ogc:PropertyName>sys.siteuuid</ogc:PropertyName>
            <ogc:Literal>{68FF11D8-D66B-45EE-B33A-21919BB26421}</ogc:Literal>
          </ogc:PropertyIsEqualTo>
          <ogc:PropertyIsLike wildCard="*" escape="\ " singleChar="?">
            <ogc:PropertyName>apiso:ServiceType</ogc:PropertyName>
            <ogc:Literal>*opendap*</ogc:Literal>
          </ogc:PropertyIsLike>
        </ogc:And>
      </ogc:Filter>
    </csw:Constraint>
  </csw:Query>
</csw:GetRecords>
```